

Near-infrared polarimetric observations of the afterglow of GRB 000301C

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Abstract. Based on near-infrared polarimetric observations we constrain the degree of linear polarization of the afterglow light of GRB 000301C to less than 30% 1.8 days after the burst.

I INTRODUCTION

The question whether a GRB is always accompanied by a collimated outflow, often called a jet, is one of the key issues of current GRB research. Because of relativistic effects a collimated explosion will reduce the deduced energy release of a GRB by the beaming factor. Theoretical considerations have demonstrated that in the case of a collimated outflow the afterglow light can be partly linearly polarized and the degree of linear polarization p should vary with time $/1-4/$.

In 1999 we established a Target of Opportunity (ToO) program aiming at the measurement of the linear polarization of GRB afterglows. The project is being carried out at the 3.5-m telescope at Calar Alto, Spain, utilizing the near-infrared camera Omega Cass $/5/$. This instrument is equipped with a 1024×1024 HAWAII array. Thus far, it was employed in wide field mode ($0'.3/\text{pixel}$), yielding a field of view of $\sim 5' \times 5'$. The observations were performed in the K' band, using wire-grid polarizers to obtain images at four position angles (0, 45, 90, and 135°). The limiting magnitude of the combined images amounts to $K' \sim 19$.

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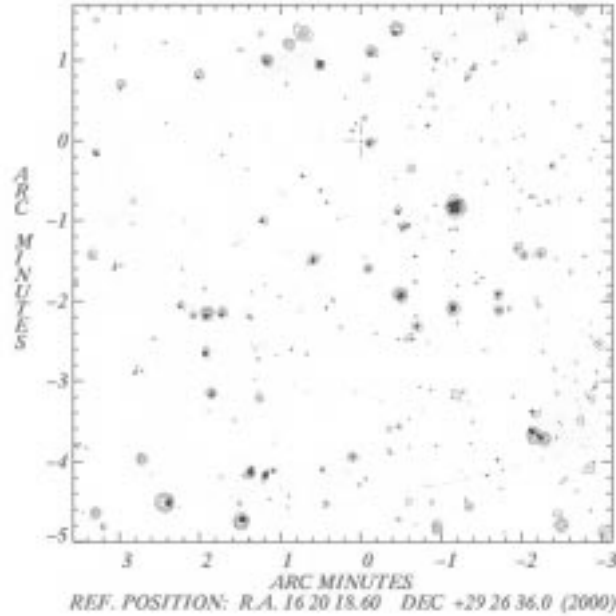


FIGURE 1. The afterglow of GRB 000301C was imaged 1.8 days after the burst with the Calar Alto 3.5-m telescope at a magnitude of $K'=17.5$ /12/. Displayed here is the combined K' -band image after adding all frames taken at four different polarization angles. The GRB afterglow is indicated by a cross. Contour lines represent the overplotted DSS-2 red image of the field.

The burst GRB 000301C was the first burst for which we can constrain the degree of linear polarization of the afterglow light.

II THE BURST GRB 000301C

The GRB 000310C was detected with *RXTE*, *Ulysses*, and *NEAR* on March 1, 2000, at 9:51 UTC /6/. In the high-energy band it lasted ~ 2 seconds /7/. The optical afterglow was soon detected on images taken on 2000 March 3.2 UT at $R = 20.3 \pm 0.5$ /8/. The redshift of the host galaxy turned out to be 2.04 /7/. A break in the afterglow lightcurve was seen some days after the burst suggesting that this burst was accompanied by a jet /9, 10/. Of particular interest is the possible detection of a microlensing event in the afterglow lightcurve /11/.

The polarimetric data were acquired at Calar Alto on March 3, 5:00 UT when the GRB afterglow was already at a magnitude of $K'=17.5$ (Fig. 1). The instrumental and interstellar contribution to the linear polarization were corrected by assuming a zero net polarization of all stars in the field. Based on aperture photometry of all well-isolated stars we can constrain p of the

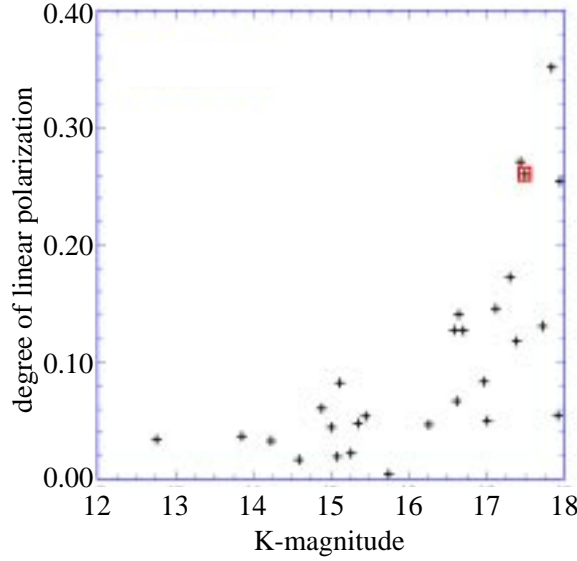


FIGURE 2. Polarization *vs.* magnitude diagram for all stars in the field ($p = 1$ corresponds to 100% polarization). The GRB afterglow is indicated by a square.

GRB afterglow to be less than 30% (Fig. 2). This result is in agreement with predictions according to which p should never exceed about 20% /1, 2/. We note, however, that our result might still be influenced by residual instrumental polarization which is currently under investigation.

III FUTURE WORK

The project entered its second year of operation in January 2001. Our results show that a GRB afterglow has to be brighter than $K' \sim 16$ in order to measure, or to constrain, its degree of linear polarization with an error of $\lesssim 10\%$ using Omega Cass. From *HETE 2* we expect rapid alerts and accurate GRB locations which would allow to use the high-resolution mode of Omega Cass. The instrumental capabilities for this mode and the larger brightness of the GRB afterglows due to the shorter response time suggest that our goal of measuring p and its temporal variation will be achievable in the near future.

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